2013-04-18 Testing of detector at composites shop with vacuum for air flow

This test is how much flow we are getting.

VENTURI

With system connected to bulkhead, d-tube etc, with sectors installed and air cover over them:
measured Δp = 0.088 psi in venturi.

Disconnecting venturi and routing hose from bulkhead:
measured Δp = 0.155 psi in venturi.

Venturi design is for 500 cfm at Δp = 1 psi.

$$\rho := \frac{14.7\text{psi}}{287.058\frac{\text{J}}{\text{kg}\cdot\text{K}}\cdot 297\text{K}} = 1.189\frac{\text{kg}}{\text{m}^3}$$

$$a_1 := (70\text{mm})^2\cdot\frac{\pi}{4} = 5.965\cdot\text{in}^2$$

$$a_2 := (50\text{mm})^2\cdot\frac{\pi}{4} = 3.043\cdot\text{in}^2$$

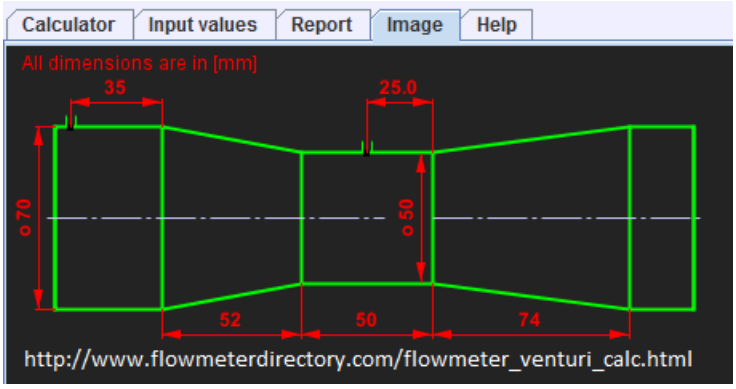
$$q(\Delta p) := \sqrt{\left(\frac{2\cdot\Delta p}{\rho}\right)\cdot\left(\frac{1}{a_2^2}-\frac{1}{a_1^2}\right)^{-1}}$$

$$q\left[\begin{pmatrix}0.088\\0.155\\1\end{pmatrix}\text{psi}\right] = \begin{pmatrix}154.6\\205.1\\521\end{pmatrix}\cdot\text{cfm}$$

<-- measured, with detector system

<-- measured, no detector system

<-- venturi design point



ANEMOMETER

As a check, also used a propeller anemometer to measure average flow velocities.

At a convenient location at the entrance of the aluminum detector air cover:
v ~ 6 m/s

At the vent outlet of the Ryvac vacuum cabinet (with pxl system fully assembled):
v ~ 3 m/s over a 250mm diameter area (with ~20% blockage due to grating)

At the duct hose just ahead of the venturi (decoupled from bulkhead, so only attached to the vacuum):
v = 25-37 m/s, from edge to center

$$v_{at\_air\_cover} := 6\frac{m}{s} = 13.4\,mph$$

$$v_{at\_vacuum\_outlet} := 3\frac{m}{s} = 6.7\,mph$$

$$q_{at\_vacuum\_outlet} := v_{at\_vacuum\_outlet}\cdot\frac{\pi}{4}\cdot(250mm)^2\cdot(1-20\%) = 249.6\,cfm$$

$$v_{at\_duct\_hose} := \begin{pmatrix}25\\37\end{pmatrix}\frac{m}{s} = \begin{pmatrix}55.9\\82.8\end{pmatrix}mph$$

$$q_{at\_duct\_hose} := v_{at\_duct\_hose}\cdot\frac{\pi}{4}\cdot(75mm)^2 = \begin{pmatrix}234\\346.4\end{pmatrix}cfm$$

--> compare to venturi measurement:

$$q(0.155psi) = 205.1\,cfm$$